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Topographic Mapping in Virginia

Need for Topographic Mapping

The economic and industrial development of any area is controlled in a large measure by the availability of facts on the natural resources of that area. The naturally occurring rock and mineral products of Virginia that have played an important part in our economic development include coal, limestone, ground water, ores of iron, zinc, lead, manganese, and other useful materials. The occurrence of these resources is controlled by the very rock and underlying structures that exist below the surface of the ground. A thorough knowledge of the geology of Virginia is a prerequisite to the future development and conservation of these resources.

Adequate topographic maps are essential for detailed geologic studies and to mineral resource evaluation studies. These maps are so fundamental to agriculture and forestry that all orchards and woodlands are depicted by use of a green overprint. The use of topographic maps by the mining industry, petroleum industry, and in ground-water and surface-water studies is well known, but these maps are also fundamental tools in industrial and area development, city and county engineering, communications, water works and water pollution studies, general engineering, highway engineering, power, military and civil defense, disaster relief, medical and health services, real estate, sports and recreation, and in other activities.

The topographic maps are prepared and printed by the United States Geological Survey and other Federal agencies. This activity is carried out by the State-Federal cooperative program in which funds are matched dollar for dollar; and by a Federal program that is independent of the cooperative program, and for which only Federal funds are used. The present level of the cooperative mapping program in Virginia is at the rate of $80,000 a year, $40,000 of which is Virginia's share. To date only 15 per cent of the State is covered by maps that meet "modern" map standards. To complete the State coverage with "modern" maps would require a $6,000,000 program, $3,000,000 of which would be Virginia's share. This program could be carried out over a period of six years with an annual investment of $500,000 by the State. During that time approximately $475,000 of Federal funds would be expended by Federal mapping agencies on other than cooperatively financed projects, to complete certain work already in progress or planned. Following such a six-year mapping program, it is estimated that a $120,000 annual continuation program, of which $60,000 would be contributed by Virginia, would be required to keep these maps up to date and not more than five years old.

At the request of James L. Calver, Commissioner of Mineral Resources, Mr. L. E. Lambelet* of the United States Geological Survey has prepared the following summary review of the topographic mapping program in Virginia.

History

The Topographic Division of the U. S. Geological Survey has a long record of mapping in Virginia, beginning in 1883. The early inclusion of Virginia mapping in the program of the U. S. Geological Survey is indicative of the Commonwealth's early significance to the development of the Nation as well as its strategic geographic

* Publication authorized by the Director, U. S. Geological Survey

Figure 1. A Section of the 30 Minute Mt. Vernon Quadrangle Map, Scale 1:125,000. Surveyed in 1885.

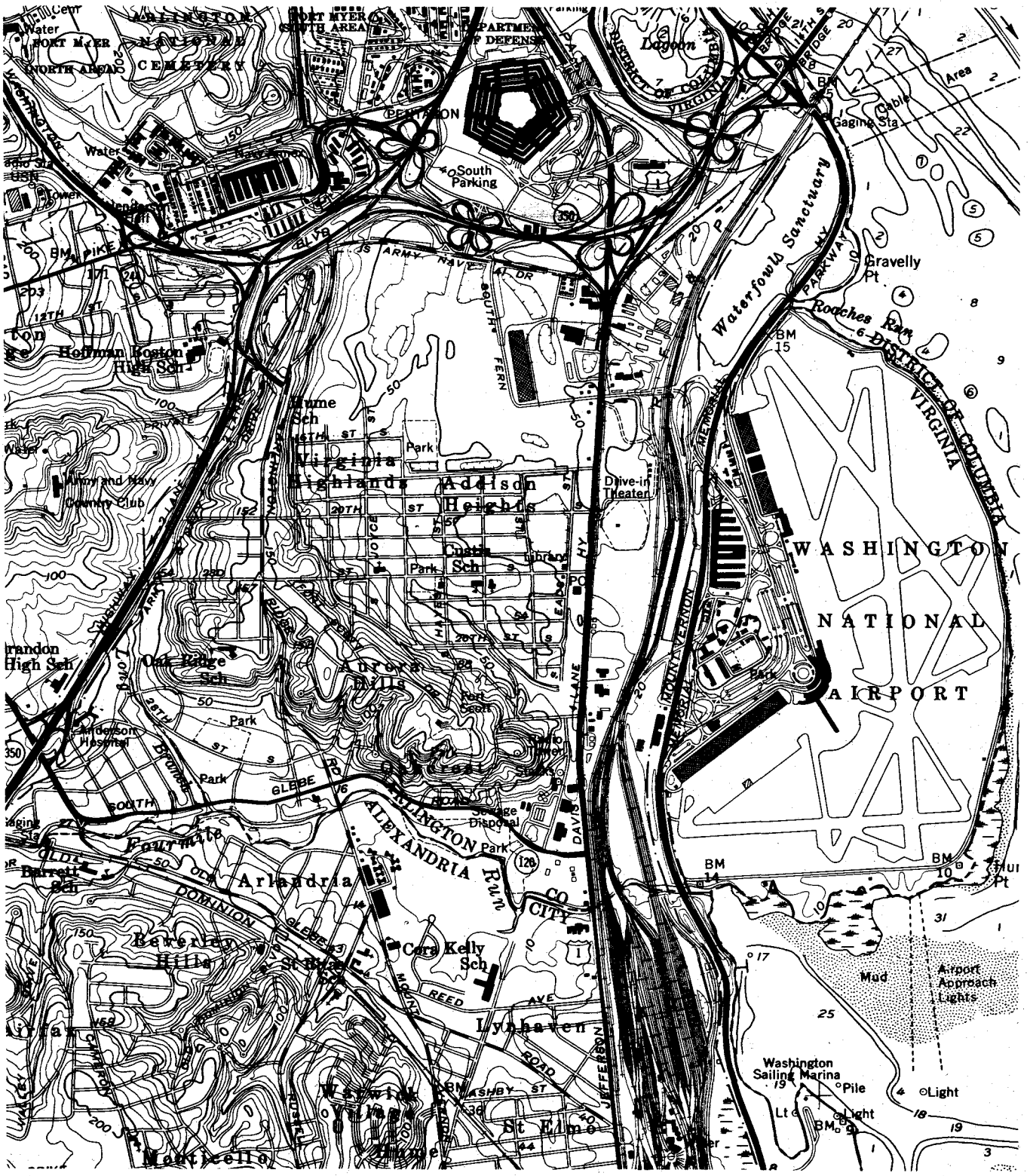

Figure 2. A Section From Same Area of Figure 1, of the Modern 7½ Minute Alexandria Quadrangle Map, Scale 1:24,000, Surveyed in 1956.

location in the middle of the Atlantic Coast. From the beginning, mapping in Virginia progressed at a steady pace. In 1908, after 25 years of work, the Commonwealth was approximately 75 percent covered by topographic maps at 1:125,000-scale (one inch to two miles). By this time only five states, West Virginia, Massachusetts, Connecticut, Rhode Island, and New Jersey, were completely mapped at that scale and Virginia ranked high among the remaining states in area mapped.

The 1:125,000-scale mapping, published in 30-minute quadrangle sheets, was then the standard for areas of average development. These first Virginia maps, by today's standards, are considered to be "reconnaissance-type" maps at best. In those days the "quality" of the map was more dependent upon the Topographer's skill in artistic sketching than in mathematical precision, and surveying methods were supplemented by ability in camping and woodsmanship, necessities for daily life in the field.

These maps, although far removed in quality from today's engineering standards, served their purpose well, and a few of them are still in use for limited purposes where modern mapping does not exist. The 1:125,000 coverage of Virginia included all of the area of the Commonwealth, except the Tidewater region and a tier of quadrangles bordering the North Carolina line westward to Hillsdale.

By 1900, the needs of the public had begun to make the 1:125,000-scale maps obsolete and it was recognized that larger scales were necessary to meet the increased demands for greater accuracy and more detail in basic topographic data. About this time the scale was changed to 1:62,500 (one inch to one mile), and until 1930 nearly all the topographic mapping was published at this scale, in 15-minute quadrangles. By 1908 at least 10 quadrangles in the Tidewater section of Virginia had been published at this scale.

The year 1908 not only marked the first 25 years of mapping in Virginia but also marked a turning point in the mapping program in the Commonwealth through an awakening by its people to the need for a progressive mapping program, for in the following year cooperative mapping began with an offering of $1,750 for State-Federal mapping. State cooperation increased substantially in subsequent years and has been continuous to the present, except for the year 1919. Through fiscal year 1959, a total of $904,330 has been contributed by the Commonwealth of Virginia and matched dollar for dollar with Federal funds for the cooperative mapping program. In addition, there has been a significant Federal mapping program.

In 1933, the end of the second 25-year period in Virginia mapping, nearly all the Tidewater section of the Commonwealth was covered by mapping at 1:62,500-scale, including the area east of a line extending through Bull Run and Richmond, except for areas near Fredericksburg equivalent to eight mile-to-the-inch quadrangles. In addition, much of the rest of the Commonwealth had been remapped at the larger scale. Aside from a few scattered 15-minute quadrangle areas, the only area of any size that was still unmapped by that time was approximately 2360 square miles along the North Carolina border, between Lawrenceville and Danville.

By the 1930's map obsolescence in terms of scale had once again become apparent and it was realized that, to meet the ever-increasing demands of modern engineering, more accurate ground information was necessary. In the late 1920's and early 1930's there was a trend to the 1:31,680-scale (2 inches to the mile), but after World War II the scale of 1:24,000 (2-½ inches to the mile, approx.) was adopted as standard for quadrangles of 7½ minute size. Both the 1:62,500 and 1:24,000-scales continued to be used, with 1:24,000 being applied to the Tidewater section and other highly developed areas.

Present Status of Mapping

After a little more than 75 years of mapping in Virginia, about 85 percent of the 39,899 square miles of the Commonwealth is covered with topographic mapping at the two largest publication scales used by the U. S. Geological Survey, but only about one-third of the Commonwealth is mapped on the increasingly demanded 7½ minute quadrangle basis. In general, the eastern third of the Commonwealth, or Tidewater region, and also the southwest part of the Commonwealth, is mapped at the scale of 1:24,000 (some at 1:31,680). The central and western parts of the Commonwealth are mapped at 1:62,500-scale as is most of the southern area.

Eight of the old 1:125,000-scale reconnaissance maps, extending southward from Luray to Farmville and then west through Bedford, are still in limited use although they are more than 60 years old (see Figures 1 and 2). At least part of each of these 30-minute quadrangles has more recent larger-scale coverage, except the Farmville quadrangle.

The total map coverage of Virginia (illustrated in Figure 3) is summarized as follows:

1:24,000-scale coverage 1:31,680-scale coverage	14,328 sq. miles
1:62,500-scale coverage	21,568 sq. miles
1:125,000-scale coverage	3,354 sq. miles

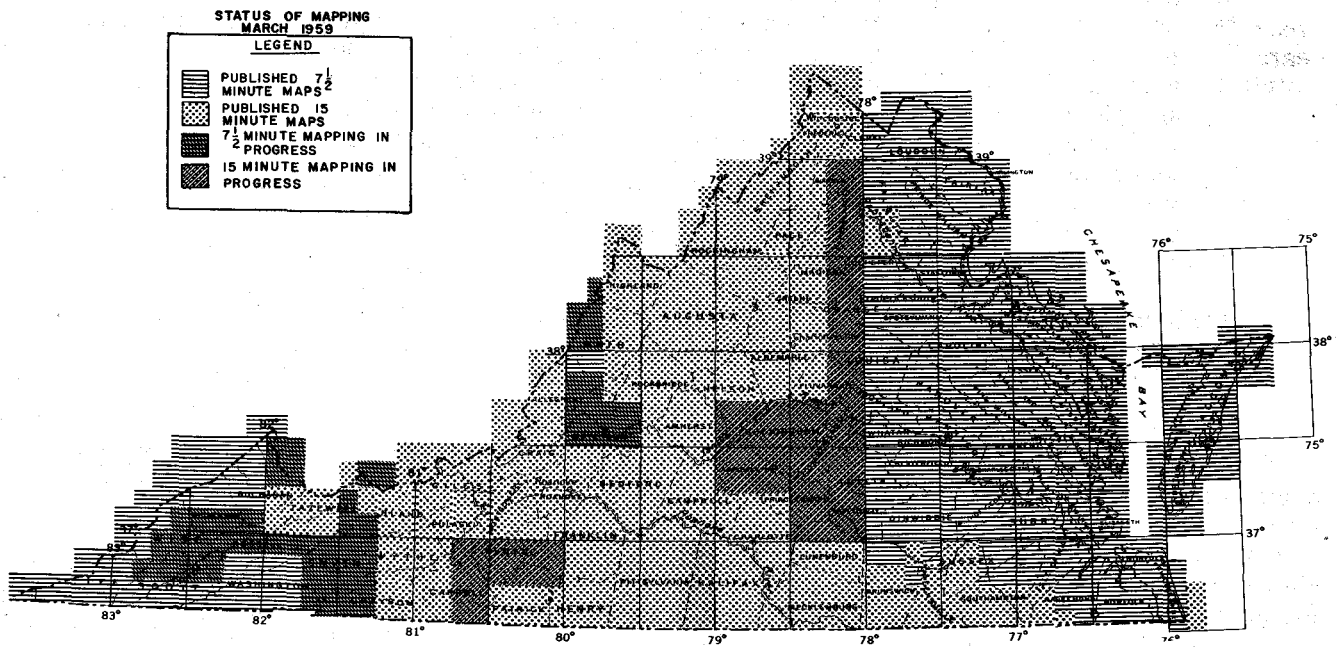

Figure 3. Status of Topographic Mapping, March 1959.

Development of Modern Equipment and Methods

By the end of the first 50-year period aerial photography and precise photogrammetric plotting instruments were gradually replacing the field methods. In about 1938, photogrammetric mapping of some Virginia areas was carried out by the U. S. Geological Survey, using the multiplex aeroprojectors.

During the year following World War II, the techniques and procedures in topographic surveying and mapping were enhanced by the development of new field techniques and improved photogrammetric instruments. Today, the list of innovations in field and photogrammetric instruments recently put into practice is impressive.

Tellurometer.—The Tellurometer, an electronic instrument for measuring distances, is being used operationally by the U. S. Geological Survey to supplement conventional traverse or triangulation. The instrument is portable, battery-operated, and capable of accuracies far in excess of the needs for topographic surveys and maps.

Automatic Level.—Automatic levels, in which the spirit bubble is replaced by a titlt-compensating pendulum device, have come into use for vertical control surveys for topographic mapping. In these instruments the line of sight is level even though the telescope is slightly titled. Since only approximate leveling of the instrument is necessary, field operations are considerably faster.

Pendulum Alidade.—Planetable alidades also employing the pendulum principle have been developed by the U. S. Geological Survey and are available commercially. Instead of a spirit bubble, these instruments use a pendulum suspension to establish a level reference plane for measuring vertical angles. Better accuracy and faster operation are the principal advantages.

Elevation Meter.—The elevation meter, a development of the Sperry-Sun Well Surveying Company, is being used by the U. S. Geological Survey to establish supplemental control for mapping large projects where there are adequate road nets. The device consists of a 4-wheel-drive, 4-wheel-steer vehicle, on which is mounted a fifth wheel to measure distance and a pendulum to measure slope. The slope and distance values are fed into an electronic computer in the truck, which determines elevation differences continuously. Traveling at normal driving speeds, the instrument can establish elevations accurate enough for stereocompilation of 10-foot contours. Although the elevation meter is not yet extensively used, it is believed to have considerable possibilities in speeding up mapping in suitable areas.

ER-55 Projectors.—The ER-55 projector, a development of the U. S. Geological Survey, to a large extent is replacing the multiplex projector within the Survey. Designed to be used with either vertical or twin low-oblique photography, the ER-55 projector utilizes an ellipsoidal reflector to provide better illumination of the projected images forming a stereoscopic model.

Twin low-oblique photography.—For many years vertical photography was generally assumed to be the most efficient medium for topographic mapping. It was known, however, that twin low-oblique photography would have certain inherent advantages if suitable instrumentation were available. With the development of ER-55 projectors and the Twinplex plotter, the way was opened for a complete twin low-oblique system for precise map compilation. Extensive mapping projects have been successfully completed and others are under way involving both convergent and transverse twin low-oblique photography.

Modern Standards

Mapping which is termed "modern" by the standards of today includes, in general, all maps compiled by modern photogrammetric or field techniques at a scale and contour interval appropriate for showing significant topographic details. Virginia maps in this category comply with the National Map Accuracy Standards which, for 1:24,000-scale maps, require that 90 percent of the well-defined planimetric points shall be plotted in correct position on the map within 1/50th inch (corresponding to 40 feet on the ground), and that 90 percent of the contours shall be accurate within half a contour interval.

Methods for the appraisal and classification of maps have been established within the U. S. Geological Survey so that all topographic maps are evaluated in a uniform and impartial manner and representations of mapping status will be qualitative as well as quantitative. Figure 3 ilustrates the status of topographic mapping in Virginia as of March 1959.

New Mapping Policy and Current Program

In 1957 the U. S. Geological Survey adopted a new policy which is intended to make extensive remapping unnecessary in future years. All new map drawings are being prepared with an accuracy and contour interval suitable for 1:24,000-scale publication. However, the finished maps may be published first at the scale of 1:62,500 in those areas where it is believed that this scale will suffice for the immediately foreseeable uses. Future demands for 1:24,000-scale maps can then be met, quickly and economically, by using the original large-scale manuscripts after they have been updated by a cultural revision.

The current mapping program in the State (see Figure 3) contains about 4640 square miles, mainly along transportation routes, areas of water development, and conservation projects, and includes all of the area now covered by the old 1:125,000-scale maps. The mapping is in various stages of progress, from basic control surveys through photogrammetric and planetable phases and cartography, with completion expected by 1963. Although this program will complete the coverage of the State with 7½ and 15-minute quadrangle maps as described previously, the growing demand for 1:24,000-scale and the need for revision of present maps will require a continuing program.

Topographic Mapping and State Development

The importance of topographic mapping to the development of State resources has been recognized by more and more states throughout the country. An outstanding example is Kentucky, which in 1956 completed a 6-year program to attain complete 7-½ minute topographic map coverage of that Commonwealth. Since that time, innumerable examples of the benefits to the State in mineral resource development, industrial growth, highway construction, and many other progressive activities have been cited. The reaction of the map-using public in Kentucky is summed up by one consulting engineer who stated that "this program is one of the most valuable and far-reaching ever undertaken by Kentucky." The Deputy Highway Commissioner of Kentucky believes that the entire cost of the State topographic mapping program was saved in a single project, in the location of approximately 100 miles of the new Interstate Highway System.

Other states are following this example of approaching their resource development problems by first obtaining accurate basic data in the form of topographic surveys so that plans can be transformed into action by procedures that take full advantage of all natural conditions. Ohio is now in the process of expanding its cooperative mapping program to complete the coverage of the State with 7½ minute mapping at 1:24,000-scale in 4 years. In Colorado, a crash program of topographic mapping was strongly recommended by the Mineral Resources Subcommittee of the Governor's Advisory Committee on Natural Resources. The subcommittee emphasized the urgency of such a program by stressing that topographic maps are an absolute necessity in every phase of the development of the State.

Plans for Future Economic Development

In keeping with this trend, the Commissioner of Mineral Resources and State Geologist of Vir-

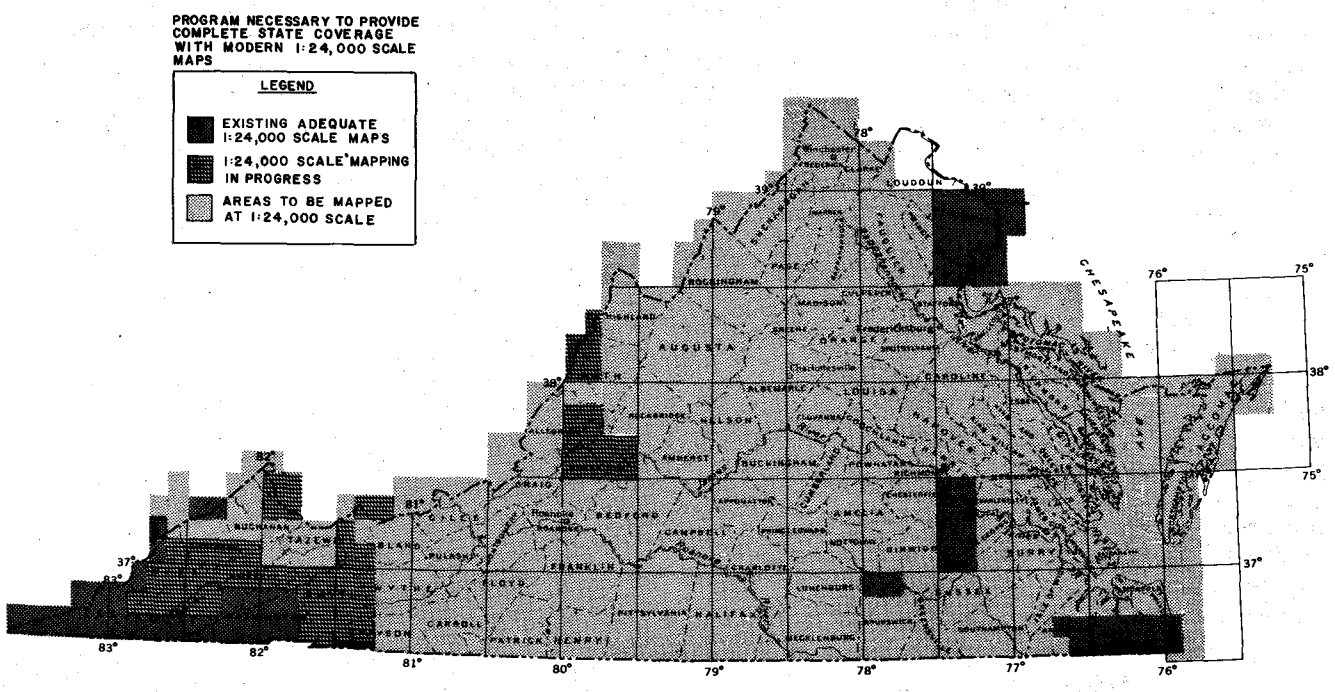

Figure 4. Program Necessary to Provide Complete State Coverage With Modern 1:24,000 Scale Maps.

ginia, working with the U. S. Geological Survey, has studied the mapping situation in terms of the ever-increasing need for complete coverage of the Commonwealth at 1:24,000-scale.

A plan has been devised which comprises the remapping of about 31,000 square miles presently covered by 1:62,500-scale maps and the completion of work in progress. The plan contemplates a cooperative mapping program between the State of Virginia and the U. S. Geological Survey, to be initiated upon the passage of State legislation to provide the necessary State funds. Figure 4 shows the areas which would be affected by the proposed plan.

Such a program seems justified alone by the variety and extent of mineral resources in Virginia. The geology of the Commonwealth is so complex that a great variety of minerals exist, a number of which are produced. Thirty-five different rock and mineral materials are reported to be in commercial production in Virginia, with the greatest variety coming from the Piedmont and Blue Ridge counties, areas that are covered by small-scale mapping. Mineral production is recorded in 65 of the 98 Virginia counties.

Preliminary figures for 1957 show that the value of mineral production in Virginia reached an all-time high of $227 million for raw materials at the mines, quarries, and plants. In addition, many of these materials were processed, transported, and sold within Virginia as finished products, increasing the quoted value of the raw materials by several times. An industry of this magnitude offers a fruitful field for the many savings that can be realized from modern map coverage as proposed in the new plan. It is estimated that these savings and other advantages realized from the use of the maps will more than repay the cost of the program in a few years. This is true not only in the field of mineral resource development but in any program that involves engineering operations on a broad scale.

It may well be that this new program will provide the stimulus for economic growth in Virginia to an extent greater than previously possible, by providing map coverage that will, with periodic updating, meet the needs of the future and guarantee continued usefulness.

Continuation Program for Map Revision

When the mapping program has progressed to the point where all quadrangles in the Commonwealth have been included, map maintenance will be undertaken. The first step includes an evaluation to determine which quadrangles should be revised first. The order and number of quadrangles to be revised will be based on the evaluation and the funds available. Every effort will

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be made to update the mapping as often as necessary to maintain the value of the maps to the public.

How To Get Topographic Maps

Maps may be purchased by mail simply by addressing the order to the U. S. Geological Survey, Washington 25, D. C. An Index to Topographic Mapping in Virginia is available upon request, at no charge; it describes all maps that are available in the State and is a most useful reference for ordering maps by mail.

The Map Information Office, U. S. Geological Survey, Washington 25, D. C. is maintained expressly for the purpose of answering questions from map users and providing information concerning maps. Also, maps may be purchased over-the-counter at this office.

Maps may also be purchased directly from the following agents in Virginia, who carry stocks of some or all of the maps available in the Commonwealth and sell them at prices usually silghtly higher than those charged by the U. S. Geological Survey:

CHARLOTTESVILLE:
Virginia Division of Mineral Resources
Box 3667, University Station

LYNCHBURG:
J. P. Bell Company
816 Main Street

NEWPORT NEWS:
E. Smola Company
134 Twenty-fifth Street

NORFOLK:
Henry Eagleton Company
430 Boush Street

RICHMOND:
Everett Waddey Company
1105 East Main Street

ROANOKE:
C. B. Malcolm & Son
632 Commerce St., S. W.
P. O. Drawer 1178

New Brick Plant

Woodbridge Clay Products Company recently opened a new brick plant near Manassas, Prince William County, to produce face brick. The company also operates a brick plant at Woodbridge, Prince William County.

New Lightweight Aggregate Plant

Clinchfield Coal Company recently started production of lightweight aggregate from shale at a new plant at Clinchfield, Russell County. The product is marketed under the trade name CLINCHLITE.